

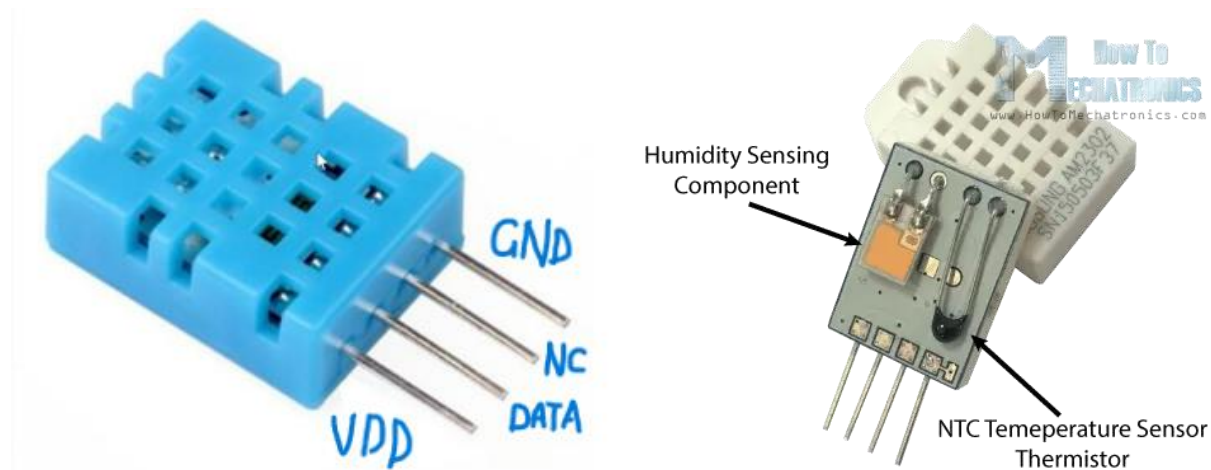
# DHT11 Digital Temperature and Humidity Sensor

The DHT11 is a digital sensor capable of measuring temperature and humidity in the environment. It uses specialized sensing technology based on humidity-sensitive components and temperature-sensitive elements, controlled by an 8-bit microcontroller that manages the humidity sensing component and the NTC thermistor.

## Internal Structure of DHT11

### DHT11 Pins:

- VDD: Power supply, provides voltage to the sensor (3.3V or 5V)
- DATA: Data transmission, communicates with the microcontroller to transfer temperature and humidity data
- NC: Not connected
- GND: Ground

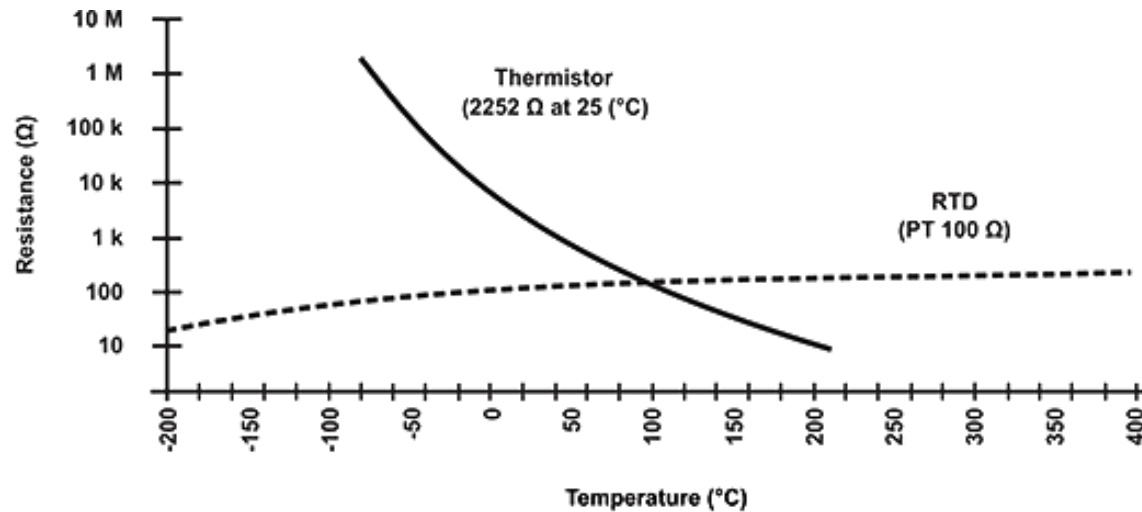


## Internal Components of DHT11: NTC Thermistor & Capacitive Humidity Sensor

### Thermistor:

A thermistor is a resistor sensitive to temperature changes. Its resistance varies with temperature. There are two main types: Negative Temperature Coefficient (NTC) and Positive Temperature Coefficient (PTC). The resistance of NTC thermistors decreases as temperature increases, while the resistance of PTC thermistors increases as temperature rises.

NTC thermistors are made from materials that are temperature-sensitive. These materials' resistance decreases with increasing temperature. Typically composed of metal oxides (such as nickel, cobalt, and manganese), NTC thermistors are formed by sintering and generally feature a two-terminal design, creating a sensitive semiconductor oxide ceramic disc or bead structure.



The relationship between the resistance of an NTC thermistor and temperature is non-linear and can usually be determined using the Steinhart-Hart equation or look-up tables:

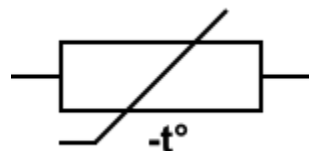
$$1/T = A + B \cdot \ln(R) + C \cdot (\ln(R))^3$$

$$T = 1 / (A + B \cdot \ln(R) + C \cdot (\ln(R))^3)$$

where T is the temperature in Kelvin, R is the resistance value, A, B, and C are specific constants for the material.

## Principle of Temperature Detection Sensor:

NTC thermistors provide highly accurate temperature measurements, especially within specific temperature ranges. Due to their small size and high thermal conductivity, NTC thermistors can quickly respond to temperature changes.



## Capacitive Humidity Sensor:

The DHT11 capacitive humidity sensor has a dielectric material that is sensitive to humidity. The humidity detection capacitor consists of two electrodes with a moisture-retaining substrate as the dielectric between them. As the humidity in the air changes, the dielectric constant of this material changes, leading to a change in capacitance. The capacitance value varies with humidity levels: as humidity increases, the dielectric constant and capacitance increase; as humidity decreases, the dielectric constant and capacitance decrease. The sensor continuously monitors changes in capacitance and converts them into humidity data.

